$\vec{V}_{Al} = 1100\,cm^3 \times \left(\frac{1\,m}{100\,cm}\right)^3 = 1.1\times10^{-4}\,m^3$

$\rho_{Al} = 2,700\,kg/m^3$

$\rho_{ETH} = 790\,kg/m^3$

a)

$\vec{F}_{net,y} = m\vec{a}_y$

so

$T + F_B - m_{Al}g = 0$

$T = m_{Al}g - F_B$

now $F_B = \rho_{ETH} V_{ETH} g = \rho_{ETH} V_{Al} g = m_{ETH} g$

now

$m_{Al} = \rho_{Al} V_{Al} = \left(2,700\,\frac{kg}{m^3}\right)(1.1\times10^{-4}\,m^3) = 0.297\,kg$

$m_{ETH} = \rho_{ETH} V_{Al} = \left(790\,\frac{kg}{m^3}\right)(1.1\times10^{-4}\,m^3) = 0.0869\,kg$

$T = (m_{Al} - m_{ETH})g = (0.297\,kg - 0.0869\,kg)(9.8\,m/s^2)$

$\boxed{T = 2.1\,N}$

2. $n = 0.10\,\text{mol}$ of ARGON

$V_i = 55\,\text{cm}^3 \times \left(\frac{1\,\text{m}}{100\,\text{cm}}\right)^3 = 5.5\times10^{-5}\,\text{m}^3$ NOW $pV = nRT$

$T_i = 296\,\text{K}$, $V_f = 220\,\text{cm}^3 = 2.2\times10^{-4}\,\text{m}^3$

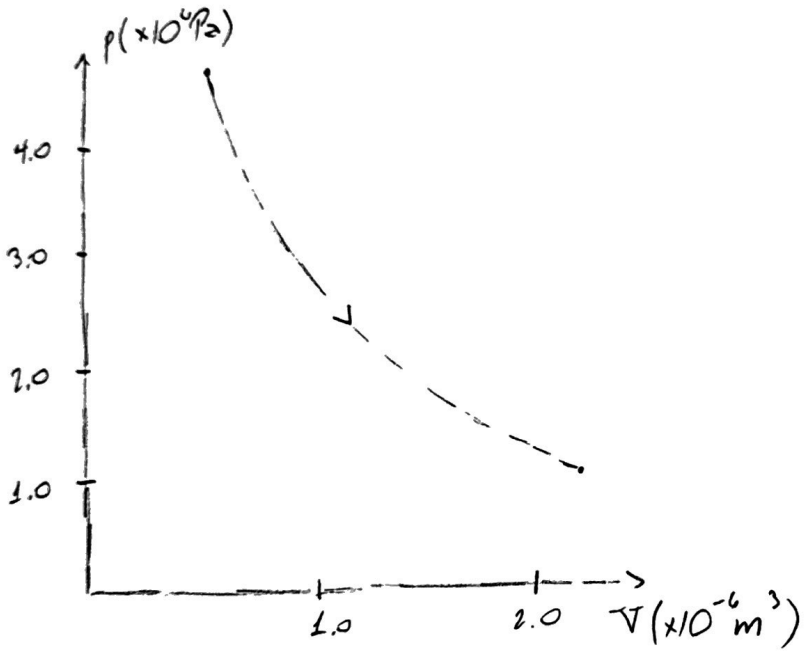
INITIAL

a) $p_i = \frac{nRT_i}{V_i} = \frac{(0.10\,\text{mol})(8.31\,\text{J/mol·K})(296\,\text{K})}{(5.5\times10^{-5}\,\text{m}^3)} = 4.47\times10^6\,\text{Pa}$

ISOTHERMAL EXPANSION $T_f = T_i$ so

$p_i V_i = p_f V_f \Rightarrow p_f = p_i \frac{V_i}{V_f} = (4.47\times10^6\,\text{Pa})\frac{(5.5\times10^{-5}\,\text{m}^3)}{(2.2\times10^{-4}\,\text{m}^3)}$

$[p_f = 1.11\times10^6\,\text{Pa}]$



$P_1 = 3.03\times10^5 Pa = P_2$

$= 100\,cm^3 \times \left(\frac{1\,m}{100\,cm}\right)^3 = 1.0\times10^{-4} m^3$

$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2} = \frac{P_3V_3}{T_3}$

$V_2 = 3000\,cm^3 = 3.0\times10^{-4} m^3 = V_3 = 3V_1$

$T_1 = T_3 = 100°C = 373K$

Quantities 1 : 2, isobaric process so $P_1 = P_2$

$\frac{V_1}{T_1} = \frac{V_2}{T_2} \therefore T_2 = T_1\frac{V_2}{V_1} = 373K\left(\frac{3V_1}{V_1}\right) = 1{,}120K$

) $T_1 = T_3 = 373K$

$T_2 = 1{,}120K$

) For process 1→2, isobaric process...

$\Delta E_{th} = nC_v\Delta T =$ now $PV = nRT$ so $n = \frac{PV}{RT} = \frac{(3.03\times10^5 Pa)(1.0\times10^{-4} m^3)}{(8.31\,J/mol\cdot K)(373K)}$

$= (9.78\times10^{-3} mol)\left(12.5\frac{J}{mol\cdot K}\right)(1{,}120K - 373K)$ $= 9.78\times10^{-3} mol$

$[\Delta E_{th} = 91J]$

$W = -p\Delta V = -(3.03\times10^5 Pa)(3.0\times10^{-4} m^3 - 1.0\times10^{-4} m^3) = -61J$

$[W = -61J]$

now $\Delta E_{th} = Q + W$ so $Q = \Delta E_{th} - W = 91J - (-61J) = 152J$

$[Q = 150J]$

) For Process 2→3, isochoric process $\therefore W = 0J$

$\Delta E_{th} = nC_v\Delta T = (9.78\times10^{-3} mol)(12.5\,J/mol\cdot K)(373K - 1120K) = -91J$

$\Rightarrow \Delta E_{th} = W + Q = Q$

$\Rightarrow$

$[\Delta E_{th} = Q = -91J] \therefore [W = 0J]$

4. $m_{Fe} = 0.512\,kg$

$T_{i,Fe} = 790°C = 1,063\,K$

$m_{H_2O} = 0.210\,kg$

$T_{i,H_2O} = 22°C = 295\,K$

$T_{f,Fe} = T_{f,H_2O} = 100°C = 373\,K$

$V_{H_2O} = 210\times10^{-3}\,L \times \frac{1\,m^3}{1000\,L} = 2.1\times10^{-4}\,m^3$

so

$m = \rho_{H_2O} V_{H_2O} = (1,000\,kg/m^3)(2.1\times10^{-4}\,m^3) = 0.210\,kg$

$Q_{Fe} + Q_{H_2O} = 0$

$m_{Fe} c_{Fe} (373K - 1063K) + m_{H_2O} c_{H_2O} (373K - 295K) + m^*_{H_2O} L_{V,H_2O} = 0$

so

$$m^*_{H_2O} = \frac{-m_{Fe} c_{Fe}(-690K) - m_{H_2O} c_{H_2O}(78K)}{L_{V,H_2O}}$$

$$= \frac{-(0.512\,kg)(449\,J/kg\,K)(-690K) - (0.210\,kg)(4,190\,J/kg\cdot K)(78K)}{(22.6\times10^5\,J/kg)}$$

$$= \frac{1,586\times10^5\,J - 6.86\times10^4\,J}{22.6\times10^5\,J/kg} = 3.98\times10^{-2}\,kg = 39.8\,g$$

so the fraction of the H_2O that boils off is..

$$\frac{m^*_{H_2O}}{m_{H_2O}} = \frac{39.8\,g}{210\,g} = 0.19$$